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FLEXIBLE FLUID LINE CONNECTOR ASSEMBLY

[0001] This application claims the benefit of U.S. Provisional Application No. 60/395,823, filed on July 15, 2002, which is hereby incorporated herein by reference in its entirety.

Background of the Invention

[0002] This invention relates to the art of fluid line connector assemblies and, more particularly, to thin-walled, flexible fluid line connector assemblies for use in low-pressure applications.

[0003] Thin-walled, flexible fluid line connector assemblies have been provided heretofore and generally include a length of thin-walled, corrugated, flexible tubing having opposing non-corrugated tubing ends, a flare nut retained on each tubing end and a flare fitting cooperable with each flare nut to form a fluid-tight seal between the flare fitting, tubing end and flare nut. The tubing ends commonly include a generally cylindrical journal portion and a radially outwardly extending flare portion. The flare nuts are retained on the non-corrugated tubing ends by the flare portion, which is deformed radially outwardly after assembly with a flare nut to engage the flare nut and thereby prevent removal thereof from the length of tubing. To form the fluid-tight seal with the flexible tubing, a flare fitting is threadably engaged into each of the flare nuts. The flare fitting includes a frustoconical leading surface which compressively engages the flare portion of the tubing end. As the flare fitting and flare nut are threadably tightened together, the frustoconical leading surface of the flare fitting displaces the flare portion of the flexible tubing against an interior surface of the flare nut. This

displacement causes the flare portion of the tubing to be compressively engaged between the flare fitting and flare nut, and causes a metal-to-metal seal to form between the tubing, the flare fitting and the flare nut such that the assembly becomes fluid tight.

[0004] A disadvantage of connector assemblies of the foregoing nature is that tightening the flare nut and flare fitting together to form the metal-to-metal seal with the flexible tubing causes the flare fitting, flare nut and flexible tubing to become rotatably fixed relative to one another. As such, the flare fitting and flare nut are not able to rotate relative to the thin-walled, flexible tubing. As a result, the flexible tubing can become torsionally stressed during the installation of the connector assembly, such as installation between a gas supply line and an appliance.

[0005] Additionally, such connector assemblies undesirably include an additional threaded connection or joint which can be the source of leaks. The flare fitting and flare nut are threadably connected together to forming a metal-to-metal seal with the flexible tubing. Opposite the threaded portion of the flare fitting that engages the flare nut is a male or female pipe thread which then must threadably engage a corresponding thread, such as on a gas supply line or appliance, for example. As such, two threaded connections are necessary at each end of the gas line connector assembly to install the same in a typical manner. Furthermore, three or more threaded connections may be necessary if additional connecting devices, such as quick-connect fittings or multi-plane swivel fittings, are installed. It will be appreciated that the more threaded connections that are used, the greater the opportunity for leaks to develop.

[0006] Also, connections between end fittings are generally not seamless. Rather, the edges on the fittings and the axial gaps therebetween, which open radially outwardly from the fluid passages that extend through the fittings, create annular

cavities that can disrupt the flow of fluid through the passage extending through the fittings. Furthermore, the gaps and edges cause resistance to fluid flow between the passages. Therefore, each additional fitting added to an end of the connector assembly causes an increase in the resistance to fluid flow through the completed assembly, due at least in part to the attendant gap and edges from the additional fitting or fittings.

[0007] Furthermore, the flare fitting is an additional component that must be inventoried, shipped and installed. In most cases, two flare fittings are used for each assembly. As such, this undesirably adds significant manufacturing, inventory and shipping costs to the finished assembly.

Brief Summary of the Invention

[0008] In accordance with the present invention, a thin-walled, flexible fluid line connector assembly is provided that avoids or minimizes the problems and difficulties encountered in connection with connector assemblies of the foregoing nature while promoting an increase in performance and reliability, and maintaining a desired simplicity of structure, economy of manufacture and ease of installation.

[0009] More particularly in this respect, a fluid line connector assembly is provided that includes a length of flexible tubing having a tubing end. An end fitting is rotatably supported on the tubing end, and a sealing member is compressively positioned between the tubing end and the end fitting. A retainer extends from the tubing end and engages the end fitting preventing the axial removal of the same from the tubing end.

[0010] Additionally, a fluid line connector assembly is provided that includes a length of flexible tubing having a generally cylindrical tubing end. An end fitting is also provided that has an inside wall at least partially defining a passage through the end fitting. The passage is adapted to receive the tubing end such that the end fitting is

rotatably supported on the tubing end. A sealing member is sealingly disposed between the tubing end and the end fitting. A retainer extends from the tubing end radially outwardly beyond the inside wall of the end fitting such that the end fitting is axially retained on the tubing end.

[0011] A method of assembling a fluid connector assembly is also provided and includes the steps of providing a length of flexible tubing having a tubing end, providing an end fitting having an inside wall at least partially forming a passage through the end fitting, and providing a sealing member. Another step includes installing the sealing member on one of the tubing end and the end fitting. Still another step includes installing the end fitting on the tubing end such that the passage receives the tubing end and the sealing member is compressively positioned between the tubing end and the end fitting. Still another step includes forming a retainer on the tubing end to axially retain the end fitting thereon.

Brief Description of the Drawings

[0012] FIGURE 1 is a cross-sectional view of a conventional connector assembly shown partly assembled.

[0013] FIGURE 2 is a cross-sectional view of the conventional assembly of FIGURE 1 shown fully assembled.

[0014] FIGURE 3 is a partial cross-sectional view of a fluid line connector assembly in accordance with the present invention.

[0015] FIGURE 4 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly in FIGURE 3.

[0016] FIGURE 5 is a partial cross-sectional view of the fluid line connector assembly in FIGURE 3 shown with quick-connect end fittings.

[0017] FIGURE 6 is a partial cross-sectional view of the fluid line connector assembly in FIGURE 3 shown with multi-plane end fittings.

[0018] FIGURE 7 is a partial cross-sectional view of an alternate embodiment of a fluid line connector assembly in accordance with the present invention.

[0019] FIGURE 8 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 7.

[0020] FIGURE 9 is a partial cross-sectional view of another alternate embodiment of a fluid line connector assembly in accordance with the present invention.

[0021] FIGURE 10 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 9.

[0022] FIGURE 11 is a partial cross-sectional view of still another alternate embodiment of a fluid line connector assembly in accordance with the present invention.

[0023] FIGURE 12 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 11.

[0024] FIGURE 13 is a partial cross-section view of yet another alternate embodiment of a fluid line connector assembly in accordance with the present invention.

[0025] FIGURE 14 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 13.

[0026] FIGURE 15 is a partial cross-sectional view of a further alternate embodiment of a fluid line connector assembly in accordance with the present invention.

[0027] FIGURE 16 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 15.

Detailed Description of the Invention

[0028] It will be appreciated that FIGURES 1 and 2 respectively illustrate a conventional fluid line connector assembly for connection between a fluid transmission line and an appliance, such as a gas supply line and a gas stove, for example. Such fluid line connector assemblies are generally known by those skilled in the art, and the following discussion of FIGURES 1 and 2 is merely provided to establish background environment and terminology for further discussion of the preferred embodiments of the present invention.

[0029] FIGURE 1 illustrates a conventional fluid line connector assembly **10** that includes a length of thin-walled, flexible tubing **20**, a flare nut **40** and a flare fitting **60**. Length of tubing **20** has two opposing tubing ends **22**, only one of which is shown in FIGURES 1 and 2. Tubing end **22** terminates at a tubing end edge **24** and includes a journal portion **26** and a flare portion **28**. Length of thin-walled, flexible tubing **20** has a plurality of helically extending tubing corrugations **30** and is formed from metal, typically stainless steel.

[0030] Flare nut **40** is retained on at tubing end **22** of tubing **20**. The flare nut has a threaded end **42** and a strain-relief end **44**. A journal passage **46** extends through flare nut **40** and is cooperable with journal portion **26** of tubing end **22** such that the flare nut is freely rotatable about a central axis **CL** of assembly **10** as shown by arrows **A**. Extending toward threaded end **42** from journal passage **46** is flare seating surface **48**, which extends radially outwardly from the journal passage in a frustoconical manner. Female fitting threads **50** extend inwardly from threaded end **42** toward flare seating surface **48**. The female fitting threads are generally coaxial with journal passage **46**. Opposite female fitting threads **50** at strain-relief end **44** is an axially-extending annular recess **54** that extends from the strain-relief end toward the threaded end and is

adapted to receive at least a portion of one or more of corrugations **30**. Wrench flats **52** extend along at least a portion of the exterior of flare nut **40**. Flare portion **28** of tubing end **22** extends radially outwardly from journal portion **26** adjacent flare seating surface **48** of flare nut **40**. As indicated by arrow **A**, in the disassembled condition, flexible tubing **20** and flare nut **40** are rotatable relative to one another.

[0031] Flare fitting **60** is shown in FIGURE 1 disassembled from tubing **20** and flare nut **40**. The flare fitting has a fitting end **62** and a connection end **68**. The fitting end has male fitting threads **64** adjacent a flare-engaging surface **66**. The connection end includes connection threads **70**. Positioned between the fitting end and the connection end of flare fitting **60** are wrench flats **72**. A fluid passage **74** extends centrally through flare fitting **60**.

[0032] FIGURE 2 shows male fitting thread **64** of flare fitting **60** engaged with female fitting threads **50** of flare nut **40**. As flare fitting **60** is threadably rotated into flare nut **40**, flare-engaging surface **66** of the flare fitting advances toward flare portion **28** of flexible tubing **20**. Ultimately, flare-engaging surface **66** contacts flare portion **28**, which is thereby forced against flare seating surface **48** effecting metal-to-metal contact between the three components. Once such contact has been made, further rotation of the flare fitting into the flare nut causes a metal-to-metal seal to form between flare-engaging surface **66** of the flare fitting, flare portion **28** of the flexible tubing and flare seating surface **48** of the flare nut. This metal-to-metal seal is suitable for forming a fluid-tight passage through connector assembly **10**. It will be appreciated, however, that this same metal-to-metal contact between the three components prevents rotation of these components relative to one another. As such, it will be appreciated that the entire connector assembly **10** must be rotated to threadably engage connection threads **70** to a fluid transmission line or appliance (not shown).

[0033] Referring now in greater detail to FIGURES 3-16, wherein the showings are for the purposes of illustrating preferred embodiments of the invention only, and not for the purpose of limiting the invention, FIGURES 3 and 4 illustrate a fluid line connector assembly **100** that includes a length of thin-walled, flexible tubing **120** with opposing ends **122**, and an end fitting **140** retained on each of the tubing ends. It will be appreciated that one or more of the embodiments disclosed herein include two opposing tubing ends and an end fitting supported on each end. However, it will also be appreciated that the use of an end fitting on both ends of the tubing is optional and that other embodiments are contemplated that have an end fitting on only one end. Such embodiments of fluid line connector assemblies are fully intended to fall within the scope of the present invention. For example, one alternate embodiment could include a length of flexible tubing having an end fitting supported on one end of the tubing in accordance with the present invention. The other end of the tubing could be brazed onto an appliance or supply line adapter forming a generally fixed connection thereto.

[0034] Returning again to FIGURES 3 and 4, length of thin-walled, flexible tubing **120** extends between tubing edges **124**. Tubing ends **122** adjacent edges **124** are non-corrugated and generally cylindrical, and the tubing ends include a journal portion **126** and a flare portion **128**. Tubing corrugations **130** extend helically along the length of flexible tubing between tubing ends **122**.

[0035] As can be better seen in FIGURE 4, end fittings **140** are supported and retained on tubing ends **122** such that the end fittings remain rotatable on the flexible tubing while still enabling the formation of a fluid-tight seal therewith. It will be appreciated that end fittings **140** shown in FIGURES 3-6 are rotatable, as indicated by arrows **RO**, relative to tubing ends **122** about a central axis **AX**. End fittings **140** have

a threaded end **142** and a strain-relief end **144**. Wrench flats **152** are positioned along the exterior of the end fitting between the threaded and strain-relief ends.

[0036] Extending centrally through the end fitting is a journal passage **146**, which is cooperable with journal portion **126** of tubing end **122** of flexible tubing **120**. Two optional seal receiving grooves **156** are positioned along journal passage **146** and extend radially outwardly into end fitting **140**. Seal members, such as o-rings **180**, are compressively positioned between one or more walls of each groove **156** and journal portion **126** of tubing ends **122**. A flare-engaging surface **148** extends radially outwardly from journal passage **146** in a generally frustoconical manner. Flare-engaging surface **148** is cooperable with flare portion **128** of the tubing end such that end fitting **120** is axially retained on the tubing end. An optional annular recess **154** extends into end fitting **140** from strain-relief end **144** such that at least a portion of one or more tubing corrugations **130** is received within the annular recess. Opposite the strain-relief end, male connection threads **158** extend along end fitting **140** at threaded end **142**. Threads **158** are shown in FIGURES 3 and 4 as tapered pipe threads. However, it will be appreciated that threads **158** may be of any suitable form or pitch.

[0037] The end fittings are shown with two seal grooves and assembled with a seal member in each groove. However, only one seal member or more than two seal members, each having a separate seal groove, may be used for each end fitting. Additionally, other configurations utilizing seal members without grooves can be used. As such, it should be appreciated that the present invention is not intended to be limited to arrangements having two seal members and two seal grooves.

[0038] In assembling the components of fluid line connector assembly **100**, a length of thin-walled, flexible tubing **120** is provided. The flexible tubing extends between

tubing edges **124** and has helical corrugations **130** along its length with non-corrugated and generally cylindrical tubing ends **122** adjacent the tubing edges. Initially, tubing ends **122** preferably include only a generally cylindrical journal portion **126**. That is, flare portion **128** is not initially formed on tubing end **122**. End fitting **140** and seal members, such as o-rings **180**, are assembled onto journal portion **126** of the tubing ends. Preferably, each o-ring **180** is inserted and captured within a seal-receiving groove **156**. Journal passage **146** of the end fitting and o-rings **180** slidably engage journal portion **126** of tubing ends **122** and are axially advanced along the journal portion until annular recess **154** engages at least a portion of tubing corrugations **130**. Flare portion **128** is then formed adjacent tubing edge **124** such that the flare portion extends radially outwardly beyond the wall that forms passage **146**. Preferably, flare portion **128** is cooperable with flare-engaging surface **148** of end fitting **140** to retain the end fitting on tubing end **122**. Due to the positioning of the seal members between the end fitting and the journal portion of the tubing end, a fluid-tight seal is formed therebetween. The end fitting is axially captured between the flare portion and the corrugations of the flexible tubing. However, the end fitting remains freely rotatable, substantially eliminating the possibility of torque-induced stress during installation.

[0039] It will be appreciated that in known fluid line connector assemblies the flare portion of the tubing end was necessary to form the metal-to-metal seal with the flare fitting and flare nut to form a fluid-tight connection. As such, the shape, form and dimensional tolerances of the flare portion were important to the formation of a fluid-tight seal. In the assembly of the present invention the flare portion of the tubing end is primarily used to retard pullout of the flexible tubing from the end fitting. While fluid line connector assemblies are often designed and manufactured to withstand a specified amount of pullout force, the flare portion of the present invention may take

any suitable form or shape to provide such desired amount of resistance to pullout. In FIGURES 3-8, the flare portion is shown as extending outwardly at approximately 45°. However, it will be appreciated that other suitable forms may be used. For example, the flare portion may be rolled or flared outwardly at a 90° from the central axis **AX**. Alternately, the flare portion can be formed in a circumferentially and/or radially discontinuous manner, for example.

[0040] FIGURES 5 and 6 illustrate fluid line connector assembly **100**, as described hereinbefore, prior to assembly with known connecting devices. FIGURE 5 shows fluid line connector assembly **100** having a length of thin-walled, flexible tubing **120** with end fittings **140** supported on opposing ends thereof, and two seal members, such as o-rings **180**, positioned between each associated end fitting and tubing end. Shown adjacent one end fitting **140** is a quick connect fitting **QC** having a female portion **QF** and a male portion **QM**. Female portion **QF** is adapted to receive, retain and form a fluid-tight seal with male portion **QM** in the manner well known in the art. Female portion **QF** includes an end surface **ES** from which female threads (not shown) extend axially into the female portion. The threads (not shown) are suitable for threadably engaging male threads **158** of end fitting **140** to form a fluid-tight connection. Male portion **QM** likewise includes an end surface **ES** from which female threads (not shown) extend axially into the fitting portion. It will be appreciated that such threads in male portion **QM** are suitable for forming a fluid-tight connection with a fluid transmission line or appliance, such as a gas supply line or gas stove (not shown), for example.

[0041] FIGURE 6 illustrates a fluid line connector assembly **100** having flexible tubing **120**, and end fitting **140** retained at each end of the flexible tubing, and two seal members, such as o-rings **180**, positioned between the end fitting and the tubing ends.

The fluid line connector assembly is shown prior to assembly with a multi-plane swivel connector **MP** adjacent each end fitting. Such multi-plane swivel connectors are generally known to those skilled in the art and include two fitting portions **FA** and **FB** which are pivotally connected in a fluid-tight manner to permit rotation about an axis **AM**. Fitting portion **FA** includes an end surface **ES'** from which female threads (not shown) extend axially into the fitting portion. It will be appreciated that such threads are suitable for forming a fluid-tight connection with male threads **158** of end fitting **140**. The second fitting portion **FB** includes a rotatable threaded end **RT** suitable for forming a fluid-tight connection with a fluid transmission line or appliance, such as a gas supply line or gas water heater (not shown), for example. It will be appreciated that various other connector devices can be used in conjunction with the end fittings of fluid line connector assembly **100**, and that the connector devices shown and described hereinbefore may be used in other combinations and in combination with other similar type fluid connector devices.

[0042] FIGURES 7 and 8 illustrate an alternate embodiment of a fluid line connector assembly in accordance with the present invention. As shown in FIGURE 7, fluid line connector assembly **200** includes a length of thin-walled, flexible tubing **220** extending between tubing edges **224** and having a non-corrugated and generally cylindrical tubing end **222** inwardly adjacent the each tubing edge. Tubing ends **222** include a journal portion **226** and a flare portion **228** extending radially outwardly from the journal portion. The length of flexible tubing **220** has helical corrugations **230** extending therealong between ends **222**.

[0043] An end fitting **240** is rotatably supported on each tubing end **222** and has a threaded end **242** and a strain-relief end **244**. Arrows **RO** indicate that each end fitting **240** is rotatable relative to an associated tubing end generally about central axis **AX'**.

An annular recess **254** suitable for receiving corrugations **230** extends axially into end fitting **240** from strain-relief end **244**. A journal passage **246** extends centrally through the end fitting and is cooperable with journal portion **226** of flexible tubing **220**. Extending radially outwardly from journal passage **246** is a flare-engaging surface **248**. Flare portion **228** of tubing end **222** is positioned adjacent flare-engaging surface **248** and is cooperable therewith. Seal receiving grooves **256** are optionally provided and are positioned along journal passage **246** and extend radially into end fitting **240**. A seal member, such as an o-ring **280**, is captured within each of grooves **256** and is compressively positioned between one of the walls of groove **256** and journal portion **226** of tubing end **222**. Positioned between threaded end **242** and strain-relief end **244** are wrench flats **252**. Threaded end **242** includes male connection threads **258** and female connection threads **259** extending therealong. Both male connection threads **258** and female connection threads **259** are shown in FIGURES 7 and 8 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection between these threads and a fluid transmission line or appliance (not shown).

[0044] It will be further appreciated that the embodiment illustrated in FIGURES 7 and 8 would be assembled in a manner substantially similar to that described for the connector assembly shown in FIGURES 3-6. As such, the steps setting out the method of assembly will not be further discussed. Furthermore, it will be appreciated that flaring of thin-walled tubing and the equipment therefore, such as flaring devices, are generally known by those skilled in the art.

[0045] FIGURES 9-12 illustrate another embodiment of a fluid line connector assembly in accordance with the present invention. As shown in FIGURE 9, fluid line connector assembly **300** includes a length of thin-walled, flexible tubing **320** extending

between tubing edges **324** and having a non-corrugated and generally cylindrical tubing end **322** inwardly adjacent each tubing edge. The length of flexible tubing **320** has helical corrugations **330** extending therealong between tubing ends **322**.

[0046] An end fitting **340** is rotatably supported on each tubing end **322** and has a threaded end **342** and a strain-relief end **344**. Arrows **RO** indicate that each end fitting **340** is rotatable relative to an associated tubing end generally about central axis **AX**. An annular recess **354** suitable for receiving at least a portion of one or more corrugations **330** extends axially into end fitting **340** from strain relief end **344**. A journal passage **346** extends centrally through the end fitting and is cooperable with tubing end **322**.

[0047] As can be better seen in FIGURE 10, a retaining groove **370** is provided in each tubing end **322**. A corresponding retaining groove **372** is provided in end fitting **340**, which is received on tubing end **322** such that grooves **370** and **372** are axially adjacent and suitable for each at least partially receiving a portion of a retaining ring **374**. A tapered surface **376** is provided adjacent annular recess **354** to facilitate assembly of the end fitting and retaining ring onto the tubing end.

[0048] Seal receiving grooves **356** extend radially outwardly from journal passage **346** and are each suitable for receiving a seal member, such as an o-ring **380**. Each seal member is captured within a different one of grooves **356** and is compressively positioned between one of the walls of the groove and tubing end **322**. Positioned between threaded end **342** and strain relief end **344** are wrench flats **352**. Threaded end **342** includes male connection threads **358** and female connection threads **359** extending therealong. Both male connection threads **358** and female connection threads **359** are shown in FIGURES 9 and 10 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-

tight connection between these threads and a fluid transmission line or appliance (not shown).

[0049] FIGURES 11 and 12 illustrate a further embodiment of a fluid line connector assembly in accordance with the present invention. It will be appreciated that the embodiment illustrated in FIGURES 11 and 12 is substantially similar to the embodiment illustrated in FIGURES 9 and 10. However, fluid line connector assembly **300'** includes end fittings **340'** in FIGURES 11 and 12, which are shown with male connection threads **358'** at threaded end **342'**, and which do not include female connection threads **359** as shown in FIGURES 9 and 10. Importantly, end fittings **340'** remain rotatable relative to the length of flexible tubing as indicated by arrows **RO**. Male connection threads **358'** are shown in FIGURES 11 and 12 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection between these threads and a fluid transmission line or appliance (not shown). Additionally, it will be appreciated that an end fitting having female threads and not including male threads is also envisioned.

[0050] Still another embodiment of the present invention is illustrated in FIGURES 13 and 14, which show a fluid line connector assembly **400** that includes a length of thin-walled, flexible tubing **420** extending between tubing edges **424** and having a non-corrugated and generally cylindrical tubing end **422** inwardly adjacent each tubing edge. The length of flexible tubing **420** has helical corrugations **430** extending therealong between ends **422**.

[0051] An end fitting **440** is rotatably supported on each tubing end **422** and has a threaded end **442** and a strain-relief end **444**. Arrows **RO** indicate that each end fitting **440** is rotatable relative to an associated tubing end generally about central axis **AX**. An annular recess **454** suitable for receiving corrugations **430** extends axially into end

fitting **440** from strain-relief end **444**. A journal passage **446** extends centrally through the end fitting and is cooperable with tubing end **422**.

[0052] A retaining groove **472** is provided in end fitting **440**. The end fitting is positioned on tubing end **422** such that a protrusion **478** extending radially outwardly from tubing end **422** engages retaining groove **472** and axially retains end fitting **440** on the tubing end. Seal receiving grooves **456** are positioned along journal passage **446** and extend radially into fitting **440**. A seal member, such as an o-ring **480**, is captured within each of grooves **456** and is compressively positioned between one of the walls of each groove **456** and tubing end **422**. Positioned between threaded end **442** and strain-relief end **444** are wrench flats **452**. Threaded end **442** includes male connection threads **458** and female connection threads **459** extending therealong. Both male connections threads **458** and female connection threads **459** are shown in FIGURES 13 and 14 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection between these threads and a fluid transmission line or appliance (not shown).

[0053] FIGURES 15 and 16 illustrate yet another embodiment of the present invention. It will be appreciated that the embodiment illustrated in FIGURES 15 and 16 is substantially similar to the embodiment illustrated in FIGURES 13 and 14. However, fluid line connector assembly **400'** includes end fittings **440'** in FIGURES 15 and 16, which are shown with male connection threads **458'** at threaded end **442'**, and which do not include female connection threads **459** as shown in FIGURES 13 and 14. Importantly, end fittings **340'** remain rotatable relative to the length of flexible tubing as indicated by arrows **RO**. Male connection threads **458'** are shown in FIGURES 15 and 16 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection

between these threads and a fluid transmission line or appliance (not shown). Additionally, it will be appreciated that an end fitting having female threads and not including male threads is also envisioned.

[0054] Assembly of connector assemblies **400** and **400'** generally includes steps substantially similar to those discussed hereinbefore with regard to connector assemblies **100** and **200** and, as such, will not be reiterated in detail. However, in assembling connector assemblies **400** and **400'**, projection **478** is preferably formed in place of flare portion **128** of connector assembly **100**. As with flare portion **128**, projection **478** can be formed in any suitable shape or configuration extending radially outwardly into groove **472** to axially retain the end fitting on the tubing end.

[0055] While the invention has been described with reference to the preferred embodiments and considerable emphasis has been placed herein on the structures and structural interrelationships between the component parts of the embodiments disclosed, it will be appreciated that other embodiments of the invention can be made and that many changes can be made in the embodiments illustrated and described without departing from the principles of the invention. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. For example, the generally cylindrical portions of the tubing ends could alternately be faceted or include flats and/or other shapes or forms. As another example, an alternate form or configuration of connection could be used instead of the male and/or female threads on the various end fittings. Accordingly, it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the present invention and not as a limitation. As such, it is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalent thereof.